Dorm Room Temperature Sensing Network

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Abstract

In response to recent student complaints about quality of life, we sought to quantify just how bad dorm rooms can be at Colby College. In this study, we narrowed our focus on room temperature, since it is easily measured and can have substantial impact on mood, sleep quality, and even academic performance. Unsurprisingly, the rooms here are cold, as we do live in Maine. However, the extent to which some rooms fail to provide adequate warmth is shocking, and demands immediate action from administration. With temperatures sometimes colder than 60°F in the middle of the room, and temperatures approaching 40°F by the windows at night, perhaps we should sleep with hats and gloves on just to survive.

1 Introduction

On Saturday October 2nd of this year, a group of about 30 Colby students refused to leave a football game start for around 90 minutes in protest of living conditions and campus culture. This event sparked a campus-wide discussion on quality of life at Colby and how it could be improved. One of the concerns raised by this group of protesters, who refer to themselves as OneColby, was that the the dorm buildings are inadequate. However, there was no mention of the actual heating and temperature management of the rooms. Since we live in Maine, it is understood that you might have to bundle up to go anywhere in the winter, but hopefully you can be comfortable in your own room. This, however, is not the case. Wide variations in temperature of rooms throughout the academic year have made our lives very difficult, but up to this point, all complaints were purely anecdotal. With this project, we hope to not only quantify the issue of dorm room temperature, but also identify probable causes and possible solutions to this problem.

1.1 Related Work

Much work has been conducted to examine the effects of room temperature on human health, function, and productivity. However, we could not find academic research done to examine the causes of these temperature changes in rooms.

Our first work [2]: "The impact of indoor air temperature on the executive functions of human brain and the physiological responses of body", examines air temperature and its effect on the body. However, they merely constrain a room to various temperatures, without considering which effects could cause the room to change to such temperatures, or even scenarios where the room temperature varies in different locations.

Our second work [3]: "Temperature sensitivity of the body surface over the life span", examines the changes in sensitivity to temperature changes as we age, which is important

information for our study to understand which changes are significant and can be detected by a human rather than a temperature sensor.

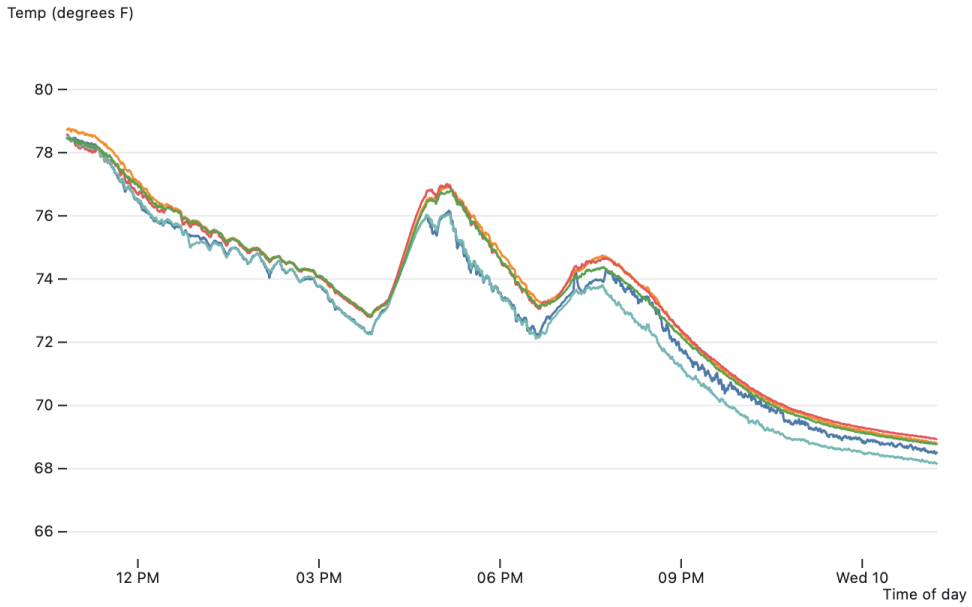
Finally, our last work [4]: "Room Temperature and Productivity in Office Work", examines the changes in productivity in office spaces for different temperatures. They use the temperature readings of the room's heating system and only minimally discuss issues such as ventilation. However, they only used well controlled commercial buildings, which likely have less temperature variations. In contrast, our dorm rooms are heated by a radiator with adjustments made from a central sensor, creating a wide range of temperature readings within and amongst rooms.

1.2 Methods

We set up a network of two Raspberry Pi 3 Model B+ units, each with five TMP117 temperature sensors. Both setups were connected to our server (GitHub), where temperature measurements were sent every minute. This data is then extracted and displayed on our dashboard so it can be viewed from anywhere [1].

First we ran a calibration run to see how consistent the different temperature sensors were to each other. We placed all five sensors in close proximity, held down by tape, next to a window to track the temperature change of the room overnight.

Figure 1: Sensor Calibration

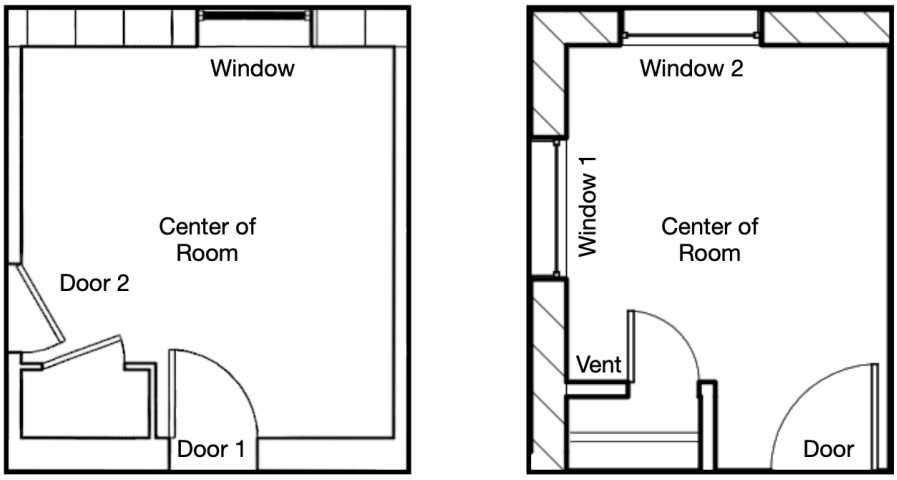


As we can see in Figure 1, all of readings from the temperature sensors were very close together an gave readings within 0.5° F of each other. This is close enough for our purposes according to our research on human temperature sensitivity [3], so we continued with our

main experiment.

We chose to use both of our dorm rooms which are located in different buildings and are different styles. Room 1 is a single bedroom within a larger quad located in the Alfond Senior Apartments on the first floor. Room 2 is the outermost room of a two-room double located in East on the first floor. This particular room has no ventilation, two doors, one window, and a radiator under the window.

Figure 2: Room Floor Plans

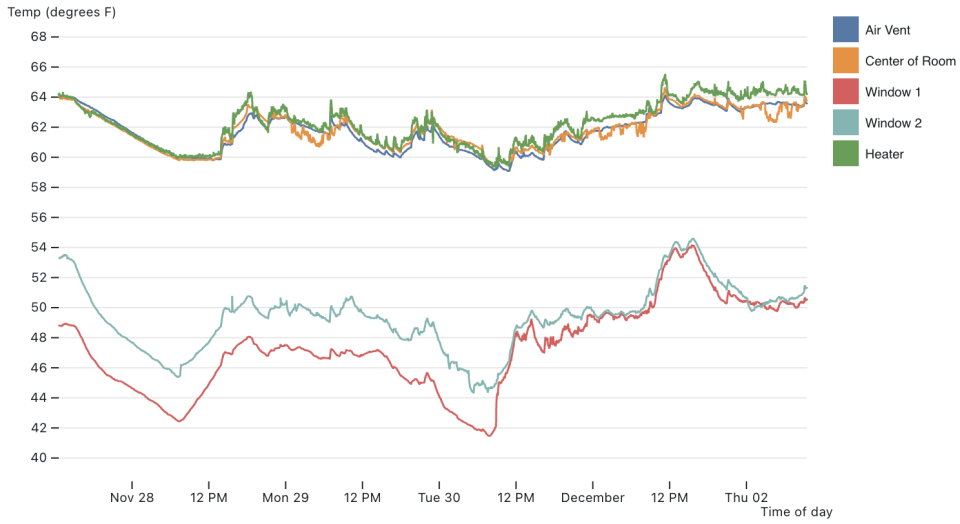


As we can see in Figure 2, both rooms are roughly similar in shape and size, though are located in different dorm buildings. We placed the temperature sensors strategically around features that can affect the temperature such as doors, windows, and radiators. In addition, we placed one sensor in the center of the room as a control measurement. This gives us the ability to determine which features are most affecting the temperature changes and produce concrete suggestions for improving the temperatures in dorm rooms.

2 Results

After running the data collection for a few days in Room 1 (Alfond Apartments 131 C), we found some strong evidence that improvements need to be made immediately.

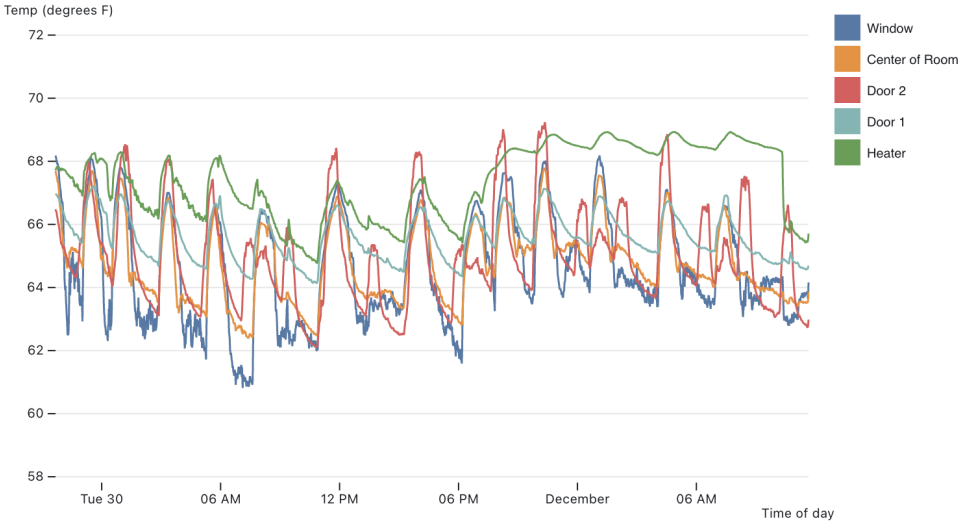
Figure 3: Temperature data from Room 1



As we can see in Figure 3, there are some serious problems with this room's insulation. Both windows are not at all good at keeping the cold air out, even while completely shut and the blinds closed. As we can see this has a dramatic affect on the overall room temperature. When the areas by the windows are very cold, we can see that the temperature of all other areas of the room can drop more than 4°F. Furthermore, the Heater in the room appears to not be functioning at all, as it barely is able to warm up the room. This shows two major flaws with the temperature control of Alfond Apartments 131C, with a third being that the room is never within a comfortable range of 68°F to 72°F.

Also, after running the data collection for a while in Room 2 (East 122), we can see what a more ideal situation might be.

Figure 4: Temperature data from Room 2



As we can see in Figure 4, Room 2 is a lot closer to what an ideal room's temperature behavior would be. While the temperature does fluctuate often, it consistently is much closer to a comfortable range of 68°F to 72°F than Room 1 ever is. Also, we can see that the window actually does a good job of insulating against the extreme cold we get in Waterville, Maine. Furthermore, the Heater actually appears to be doing its job to the best of its abilities, as it is consistently the warmest part of the room and has an impact on the temperatures of all other areas. This room, while not perfect, does not warrant immediate action or improvement, and can provide a mostly comfortable, but not perfectly ideal, quality of life for its occupants.

2.1 Conclusions and Future Work

We believe that our framework for a room temperature sensing network can be used to find problems within physical dorm rooms and identify possible solutions that not only improve the lives of Colby students, but also save the college money in the long term. If the extremely poor insulation around the windows in Alfond Apartments is replaced, it will lower overall heating costs and provide a more comfortable living experience for all residents. This will hopefully incentivize this necessary fix and cause widespread change that improves the lives of Colby students.

References

[1] Dashboard: `https://observablehq.com/@iellms/cs431-project-ellmer-maring`

[2] A. M. Abbasi et al., "The impact of indoor air temperature on the executive functions of human brain and the physiological responses of body," *Health promotion perspectives*, vol. 9, no. 1, pp. 55-64. 23 January 2019. Accessed: December, 6, 2021, doi:10.15171/hpp.2019.07. [Online]. Available: `https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6377698/`

[3] J. C. Stevens and K. K. Choo, "Temperature sensitivity of the body surface over the life span," *Somatosensory and Motor Research*, vol. 15, no. 1, pp. 13-28. 10 July 2009. Accessed: December, 6, 2021, doi:10.1080/08990229870925. [Online]. Available: `https://www.tandfonline.com/doi/abs/10.1080/08990229870925`

[4] O. Seppanen, W. J. Fisk, and Q. H. Lei, "Room Temperature and Productivity in Office Work," *Healthy Buildings*, vol. 1, no. 1, pp. 1-6. 1 July 2006. Accessed: December, 6, 2021. [Online]. Available: `https://escholarship.org/content/qt9bw3n707/qt9bw3n707.pdf`